Municipality Level Simulations of Dengue Fever Incidence in Puerto Rico Using Ground Based and Remotely Sensed Climate Data

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Dengue fever (DF) is caused by a virus transmitted between humans and Aedes genus mosquitoes through blood feeding. In recent decades incidence of the disease has drastically increased in the tropical Americas, culminating with the Pan American outbreak in 2010 which resulted in 1.7 million reported cases. In Puerto Rico dengue is endemic, however, there is significant inter-annual, intra-annual, and spatial variability in case loads. Variability in climate and the environment, herd immunity and virus genetics, and demographic characteristics may all contribute to differing patterns of transmission both spatially and temporally. Knowledge of climate influences on dengue incidence could facilitate development of early warning systems allowing public health workers to implement appropriate transmission intervention strategies. In this study, we simulate dengue incidence in several municipalities in Puerto Rico using population and meteorological data derived from ground based stations and remote sensing instruments. This data was used to drive a process based model of vector population development and virus transmission. Model parameter values for container composition, vector characteristics, and incubation period were chosen by employing a Monte Carlo approach. Multiple simulations were performed for each municipality and the results were compared with reported dengue cases. The best performing simulations were retained and their parameter values and meteorological input were compared between years and municipalities. Parameter values varied by municipality and year illustrating the complexity and sensitivity of the disease system. Local characteristics including the natural and built environment impact transmission dynamics and produce varying responses to meteorological conditions.